### Appendix A: The 2003 Social Accounting Matrix

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**Note:** features are in Billion MT

**Source:** *Author's own calculations based on Thurlow (2008)*
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**Note:** features are in Billion MT

**Source:** *Author's own calculations based on Thurlow (2008)*
## Appendix A

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## Appendix A

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**Source:** *Author's own calculations based on Thurlow (2008)*
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**Note:** features are in Billion MT

*Source: Author's own calculations based on Thurlow (2008)*
Appendix A

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Note: features are in Billion MT

Source: Author’s own calculations based on Thurlow (2008)
## Appendix A

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Note: features are in Billion MT

Source: Author's own calculations based on Thurlow (2008).
## Appendix B: The IFPRI CGE Model Specifications

<table>
<thead>
<tr>
<th>Index</th>
<th>Variable definition</th>
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<tr>
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<td>Formal activities</td>
</tr>
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<td>row;</td>
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</tbody>
</table>
### Appendix B

#### Parameters

**Parameter** | **Symbol** | **Definition**
--- | --- | ---
$va (s)$ |  | Elasticity of substitution among primary factors in the production function of sector $s$
$sigmaT (s)$ | $\sigma^T_s$ | Elasticity of transformation between domestic uses and exports in sector $s$
$relacet (s)$ |  | Elasticity of transformation among exports to different destinations
$sigmaQ (s)$ | $\sigma^Q_s$ | Elasticity of substitution between domestic uses and imports of sector $s$
$relasarm (s)$ |  | Elasticity of substitution among imports from different origins
$at0 (s)$ |  | Activity tax rate for sector $s$
$rebt0 (s)$ |  | VAT rebate tax rate for sector $s$
$st0 (g)$ |  | Sales tax rate on commodity $g$
$vtd0 (g)$ |  | VAT collected domestically tax rate on commodity $g$
$th0 (h)$ |  | Household $h$ income tax rate
$te0$ |  | Enterprise income tax rate
$mrge0 (g, r)$ |  | Share of export margins by commodity $g$ and country of destination $r$
$tm0 (g, r)$ |  | Import tax rate on good $g$ from region $r$
$vtb0 (g, r)$ |  | VAT collected at borders tax rate on good $g$ imported from region $r$

#### Prices

**Variable** | **Definition**
--- | ---
$PY (g)$ | Price index for domestic formal production $s$
$PIY (is)$ | Domestic price for home- consumed commodity good $g$
$PD (g)$ | Domestic price for marketed commodity good $g$
$PX (r, g)$ | Producer price index for exports of commodity $g$ to region $r$
$PA (g)$ | Price index for aggregate Armington supply for good $g$
$PC (h)$ | Consumption price for composite good $g$ consumed by household $h$
$PT$ | Price for transportation and marketing margins
$PG$ | Price index for government expenditures
$PTRAN$ | Price for social transfers
$PE$ | Price for distributed profits
$PINV$ | Investment price for composite good $g$
$PFX (r)$ | Exchange rate respect region $r$
$PY0(s)$ | Reference price for formal sector $s$ production gross of activity tax
$PA0(g,s)$ | Reference price for intermediate composite good $g$ employed in sector $s$ gross of VAT rebate
### Production

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>$X(s)$</td>
<td>Domestic production of exports in sector $s$</td>
</tr>
<tr>
<td>$Y(s)$</td>
<td>Domestic total production (exports + domestic uses) in sector $s$</td>
</tr>
<tr>
<td>$IY(s)$</td>
<td>Home-consumption of commodity of sector $s$</td>
</tr>
<tr>
<td>$ES(r)$</td>
<td>Exports according to destination $r$</td>
</tr>
<tr>
<td>$A(s)$</td>
<td>Domestic output of composite activity $s$</td>
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<tr>
<td>$MG$</td>
<td>Domestic output of composite margins</td>
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<tr>
<td>$C(h)$</td>
<td>Household $h$ total consumption</td>
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<tr>
<td>$G$</td>
<td>Government total consumption</td>
</tr>
<tr>
<td>$INVEST$</td>
<td>Domestic output of composite investment good</td>
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### Factors

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<td>$PF(f)$</td>
<td>Price for factor $f$</td>
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<td>$FA0(f, s)$</td>
<td>Factor $f$ demand in activity $s$</td>
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<tr>
<td>$FIA0(f, is)$</td>
<td>Factor $f$ demand in activity $is$</td>
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<tr>
<td>$HF0(h)$</td>
<td>Factor $f$ income for household $h$</td>
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<td>$EF0$</td>
<td>Factor demand $f$ income for enterprises</td>
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</table>

### Income and expenditures

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<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>$CA0(g, s)$</td>
<td>Intermediate demand of composite good $g$ in sector $s$</td>
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<tr>
<td>$CIA0(g, is)$</td>
<td>Intermediate demand of composite good $g$ in sector $is$</td>
</tr>
<tr>
<td>$CH0(g, h)$</td>
<td>Final demand of household $h$ for marketed good $g$</td>
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<tr>
<td>$IAH0(s, h)$</td>
<td>Final demand of household $h$ for home consumed products of sector $is$</td>
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<tr>
<td>$C0(h)$</td>
<td>Aggregate household $h$ consumption</td>
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<tr>
<td>$HR0(r, h)$</td>
<td>Remittances of household $h$ from region $r$</td>
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<td>$HSV0(h,)$</td>
<td>Household $h$ savings</td>
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<td>$HE0(h)$</td>
<td>Household $h$ distributed profits</td>
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<tr>
<td>$HG0(h)$</td>
<td>Household $h$ social transfers</td>
</tr>
<tr>
<td>$TP0(“YTAX”, h)$</td>
<td>Household $h$ income tax</td>
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</table>
## Appendix B

<table>
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<tr>
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<th>Definition</th>
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</thead>
<tbody>
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<td>$XE_0 (r)$</td>
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<tr>
<td>$ESV_0$</td>
<td>Enterprise savings</td>
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<td>$EG_0$</td>
<td>Enterprise social transfers</td>
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<td>$TE_0 (&quot;YTAX&quot;, h)$</td>
<td>Enterprise income tax</td>
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<td>$GD_0 (g)$</td>
<td>Final government demand for composite good $g$</td>
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<td>$FSV_0 (r)$</td>
<td>Foreign savings from region $r$</td>
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<td>$GSV_0$</td>
<td>Government savings</td>
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<tr>
<td>$GE_0$</td>
<td>Government distributed profits</td>
</tr>
<tr>
<td>$MTX_0 (r, g)$</td>
<td>Import duties on good $g$ from region $r$</td>
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<tr>
<td>$VTX_0 (r, g)$</td>
<td>VAT on imports of good $g$ from region $r$</td>
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<td>$CS (g)$</td>
<td>Final investment demand for good $g$</td>
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<tr>
<td>$TA_0 (&quot;ATAX&quot;, s)$</td>
<td>Activity tax in sector $s$</td>
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<td>$TA_0 (&quot;REB&quot;, s)$</td>
<td>VAT rebate in sector $s$</td>
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<td>$TC_0 (&quot;VTD&quot;, g)$</td>
<td>Domestic VAT on good $g$</td>
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<td>$TC_0 (&quot;STAX&quot;, g)$</td>
<td>Sales tax on good $g$</td>
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### Scaling parameters

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<th>Definition</th>
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<tbody>
<tr>
<td>$fsav (r)$</td>
<td>Scaling parameter on foreign savings from region $r$</td>
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<tr>
<td>$gsav$</td>
<td>Scaling parameter on government savings</td>
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</table>
Appendix C: The GAMS/MPSGE Code for the IFPRI Model

In this appendix we present the GAMS/MPSGE code to perform and evaluate our simulations. This code is mainly composed of 3 parts:

1) The SAM, presented in Appendix A, is called and imported into the GAMS code. Then, we check for SAM consistency imposing that rows sums equal columns sums (the notion of double-book keeping). Finally, we report if there are negative values or empty rows or columns.

2) The SAM is manipulated and we move from a square matrix with numeric indices to model-relevant subtraces with meaningful text labels. This relies on the concept of “tuples”. According to Rutherford (2003) “these are multidimensional sets which can associated a numeric index with a text index”. In our case the SAM has 37 rows and columns and in this part of the code it is broken down into 11 logical subsets, whose dimension is indicated in brackets:

<table>
<thead>
<tr>
<th>Production activities</th>
<th>A(5)</th>
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<tr>
<td>Production informal activities</td>
<td>IA(5)</td>
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<tr>
<td>Commodities</td>
<td>C(5)</td>
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<tr>
<td>Trade margins</td>
<td>M(3)</td>
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<tr>
<td>Primary factors</td>
<td>F(4)</td>
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<tr>
<td>Enterprises</td>
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<tr>
<td>Private households</td>
<td>H(2)</td>
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<tr>
<td>Government</td>
<td>G(1)</td>
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<tr>
<td>Types of taxes</td>
<td>T(7)</td>
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<tr>
<td>Rest of world</td>
<td>X(3)</td>
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<tr>
<td>Investment- savings</td>
<td>I(1)</td>
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</table>

This allows us to divide the SAM into sub-matrices as in the map below. Note that the same labels are employed later in the code. All cells with no labels are empty.

<table>
<thead>
<tr>
<th>A</th>
<th>IA</th>
<th>C</th>
<th>M</th>
<th>F</th>
<th>E</th>
<th>H</th>
<th>G</th>
<th>T</th>
<th>X</th>
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</table>
3) The model itself is constructed. Using the MPSGE solver, we need zero profit conditions (block $sectors:), market clearing conditions (block $commodities:), and income balance (block $consumers:).

$TITLE An IFPRI CGE Model for Mozambique

$ontext
This model was developed to assess the impact of the Mozambican participation into the Southern Africa Development Community (SADC). This code is part of the Ph.D. thesis "The Mozambican Participation in SADC- A Liberalization Process through Different Models and Different Closures".
The study was conducted by Elisa Delpiazzo, under the supervision of Prof. Marco Missaglia, University of Pavia. The analysis uses a GAMS/MPSGE CGE model based on the 2003 Mozambique SAM. The focus of the study is on examining the impact of a tariff reduction as the one scheduled in the SADC Trade Protocol.
$offtext

set colorder /chk/;

set i SAM rows and column indices /1*37/;

*SAM rows and columns are the same set:
alias (i,j);

table sam(i,j) Base year social accounts

*Call the SAM from the worksheet in Excel format and import it in GAMS:

$call=xls2gms i=sam5sectors2hhds3reg.xls o=sam5sectors2hhds3reg.inc
$include sam5sectors2hhds3reg.inc

*Computation works best when features are around unit, so we scale the SAM values:

sam(i,j) = sam(i,j)/1000;

display sam;

*Check the consistency of the SAM and report negative values and empty rows or columns:

parameter samchk Check of SAM consistency;
samchk(i) = (sum(j, sam(i,j)-sam(j,i)));
display samchk;
set negval(i, j) flag for negative elements;
negval(i, j) = yes$(sam(i, j)<0);
display negval;

set empty(i, *) flag for empty rows and columns;
empty(i, "row")= 1$(sum(j,sam(i,j))=0);
empty(j,"col")= 1$(sum(i,sam(i,j))=0);
display empty;

*Declare sets with which the SAM should be relabelled:

set s List of formal activities and commodities/
    AGRI agriculture fishing forestry and breeding activities,
    MIN mining,
    MAN industry (food processing and beverages light and heavy
    manufacturing metal products),
    TRADE wholesales and retail trade,
    SERV services/,

is List of informal activities and commodities/
    INF-AGRI agriculture fishing forestry and breeding activities,
    INF-MIN mining,
    INF-MAN industry (food processing and beverages light and heavy
    manufacturing metal products),
    INF-TRADE wholesales and retail trade,
    INF-SERV services/,

m Margins/
    TMD domestic sales transactions costs,
    TMM import transactions costs,
    TME export transactions costs/,

f Factors of production/
    L1 unskilled labour,
    L2 semi-skilled labour,
    L3 skilled labour,
    K capital/,

h Household /
    R-HHDS rural households,
    U-HHDS urban households /,

e Enterprise /ENTR/,

t Taxes/
Appendix C

ATAX  Activity tax (subsidy),
REB   Vat rebate (on intermediate uses),
YTAX  Income tax (for households and private firms),
VATB  VAT tax collected at borders (on imports gross of tariffs),
VATD  VAT tax collected on domestic sales,
STAX  Sales tax,
MTAX  Import tax/,

r   Regions/
    RSA   Republic of South Africa,
    ROSADC Rest of SADC,
    ROW   Rest of World/

alias (i,j), (s,g), (is,ig), (m,mm);

*Mapping the activities:

Set    mapa(i,s) Mapping from SAM to formal activities/
    1.AGRI,
    2.MIN,
    3.MAN,
    4.TRADE,
    5.SERV /,

    mapia(i,is) Mapping from SAM to informal activities/
    6.INF-AGRI,
    7.INF-MIN,
    8.INF-MAN,
    9.INF-TRADE,
   10.INF-SERV /,

    mapc(i,g) Mapping from SAM to commodities/
    11.AGRI,
    12.MIN,
    13.MAN,
    14.TRADE,
    15.SERV /,

    mapf(i,f) Mapping from SAM to factors of production /
    16.L1,
    17.L2,
    18.L3,
    19.K /,

    mapm(i,m) Mapping from SAM to marketing margins /
    20.TMD,
    21.TMM,
Appendix C

22. TME /

maph(i,h) Mapping from SAM to households /
23. R-HHDS,
24. U-HHDS /,

mape(i) Mapping from SAM to enterprise account /25/,

mapg(i) Identifying government row /26/,

mapt(i,t) Mapping from SAM to source of taxes /
27. REB,
28. ATAX,
29. VATD,
30. VATB,
31. MTAX,
32. STAX,
33. YTAX /,

mapi(i) Identifying the investment and saving row /34/,

mapx(i,r) Identifying the rest of the world /
35. RSA,
36. ROSADC,
37. ROW /;

set ss/a, ia, c, m, f, e, h, g, t, x, i/ 

*Generate a report of submatrix totals:

parameter totals(*,*)SAM totals for reporting;
totals("a","c") = sum((mapa(i,s), mapc(j,g)), sam(i,j));
totals("ia","h") = sum((mapia(i,is), maph(j,h)), sam(i,j));
totals("c","a") = sum((mapc(i,g), mapa(j,s)), sam(i,j));
totals("c","ia") = sum((mapc(i,g), mapia(j,is)), sam(i,j));
totals("c","m") = sum((mapc(i,g), mapm(j,m)), sam(i,j));
totals("c","h") = sum((mapc(i,g), maph(j,h)), sam(i,j));
totals("c","g") = sum((mapc(i,g), mapg(j)), sam(i,j));
totals("c","x") = sum((mapc(i,g), mapx(j,r)), sam(i,j));
totals("c","i") = sum((mapc(i,g), mapi(j)), sam(i,j));
totals("m","c") = sum((mapm(i,m), mapc(j,g)), sam(i,j));
totals("f","a") = sum((mapf(i,f), mapa(j,s)), sam(i,j));
totals("f","ia") = sum((mapf(i,f), mapia(j,is)), sam(i,j));
totals("e","f") = sum((mape(i), mapf(j,f)), sam(i,j));
totals("e","g") = sum((mape(i), mapg(j)), sam(i,j));
totals("h","f") = sum((maph(i,h), mapf(j,f)), sam(i,j));
totals("h","e") = sum((maph(i,h), mape(j)), sam(i,j));
Appendix C

totals("h","g") = sum((maph(i,h), mapg(j)), sam(i,j));
totals("h","x") = sum((maph(i,h), mapx(j,r)), sam(i,j));
totals("g","e") = sum((mapg(i), mapa(j)), sam(i,j));
totals("g","t") = sum((mapg(i), mapt(j,t)), sam(i,j));
totals("t","a") = sum((mapa(i,t), map(j)), sam(i,j));
totals("t","c") = sum((mapa(i,t), mapc(j,g)), sam(i,j));
totals("t","e") = sum((mapa(i,t), mape(j)), sam(i,j));
totals("t","h") = sum((mapa(i,t), maph(j,h)), sam(i,j));
totals("x","c") = sum((mapx(i,r), mapc(j,g)), sam(i,j));
totals("x","e") = sum((mapx(i,r), mape(j)), sam(i,j));
totals("i","e") = sum((mapi(i), mape(j)), sam(i,j));
totals("i","h") = sum((mapi(i), maph(j,h)), sam(i,j));
totals("i","g") = sum((mapi(i), mapg(j)), sam(i,j));
totals("i","x") = sum((mapi(i), mapx(j,r)), sam(i,j));

alias (ss,sss);

totals(ss,"total") = sum(sss, totals(ss,sss));
totals("total",ss) = sum(sss, totals(sss,ss));

option totals:1;
display totals;

*Extract sub-matrices from the SAM. When a sub-matrix is extracted the associated
*values in the original SAM are set equal to zero.

*Extraction of domestic production-related data from SAM:

Parameter

c0(s,g) Intermediate inputs demand for formal sectors,
cia0(g,is) Intermediate input demand for informal sectors,
fa0(f,s) Factor demand (or value added) for formal sectors,
fia0(f,is) Factor demand (or value added) for informal sectors,
t0(t,s) Tax collection,
iah0(is,h) Household consumption of own production,
ac0(s,g) Marketed output,
iac0(is) production of informal sectors;

loop((mapc(i,g), mapa(j,s)), ca0(g,s) = sam(i,j); sam(i,j)=0;);
loop((mapc(i,g), mapia(j,is)), cia0(g,is) = sam(i,j); sam(i,j)=0;);
loop((mapf(i,f), mapa(j,s)), fa0(f,s) = sam(i,j); sam(i,j)=0;);
loop((mapf(i,f), mapia(j,is)), fia0(f,is) = sam(i,j); sam(i,j)=0;);
loop((mapt(i,t), mapa(j,s)), ta0(t,s) = sam(i,j); sam(i,j)=0;);
loop((mapia(i,is), maph(j,h)), iah0(is,h) = sam(i,j); sam(i,j)=0;);
loop((mapa(i,s), mapc(j,g)), ac0(s,g) = sam(i,j); sam(i,j)=0;);

iac0(is) = sum(h, iah0(is,h));
Appendix C

*Extraction of commodity demand components from SAM:

Parameter

\[ mc0(m,g) \quad \text{Marketing and transportation costs,} \]
\[ tc0(t,g) \quad \text{Indirect taxes,} \]
\[ rc0(r,g) \quad \text{Value of imports at cif price,} \]
\[ cm0(g,m) \quad \text{Sales to wholesale and retail margins,} \]
\[ gd0(g) \quad \text{Government demand,} \]
\[ er0(g,r) \quad \text{Export (fob),} \]
\[ cs0(g) \quad \text{Investment demand,} \]
\[ ch0(g,h) \quad \text{Private consumption;} \]

\[
\begin{align*}
\text{loop((mapm(i,m), mapc(j,g)),} & \quad mc0(m,g) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapt(i,t), mapc(j,g)),} & \quad tc0(t,g) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapx(i,r), mapc(j,g)),} & \quad rc0(r,g) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapc(i,g), mapm(j,m)),} & \quad cm0(g,m) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapc(i,g), mapg(j)),} & \quad gd0(g) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapc(i,g), mapx(j,r)),} & \quad er0(g,r) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapc(i,g), mapi(j)),} & \quad cs0(g) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapc(i,g), maph(j,h)),} & \quad ch0(g,h) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\end{align*}
\]

*Extraction of factor-related data from SAM:

Parameter

\[ hf0(h,f) \quad \text{Factors income to households,} \]
\[ ef0(f) \quad \text{Factors income to enterprises;} \]

\[
\begin{align*}
\text{loop((maph(i,h), mapf(j,f)),} & \quad hf0(h,f) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mape(i), mapf(j,f)),} & \quad ef0(f) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\end{align*}
\]

*Extraction of household-related data from SAM:

Parameter

\[ tp0(t,h) \quad \text{Income tax payment by households} \]
\[ he0(h) \quad \text{Enterprise payment to households} \]
\[ hg0(h) \quad \text{Government transfer to households} \]
\[ hr0(h,r) \quad \text{Household income from abroad} \]
\[ hsv0(h) \quad \text{Household savings;} \]

\[
\begin{align*}
\text{loop((mapt(i,t), maph(j,h)),} & \quad tp0(t,h) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((maph(i,h), mape(j)),} & \quad he0(h) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((maph(i,h), mapg(j)),} & \quad hg0(h) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((maph(i,h), mapx(j,r)),} & \quad hr0(h,r) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\text{loop((mapi(i), maph(j,h)),} & \quad hsv0(h) = \text{sam}(i,j); \text{sam}(i,j)=0;) \\
\end{align*}
\]

*Extraction of enterprise-related data from SAM:

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Appendix C

parameter

te0(t)  Enterprise direct taxes
ge0  Enterprise dividends paid to Government
xe0(r)  Enterprise payments to foreigners
esv0  Enterprise savings
eg0  Government transfers to enterprise;

loop((mapt(i,t), mape(j)),
   te0(t) = sam(i,j); sam(i,j)=0;);
loop((mapg(i), mape(j)),
   ge0 = sam(i,j); sam(i,j)=0;);
loop((mapx(i,r), mape(j)),
   xe0(r) = sam(i,j); sam(i,j)=0;);
loop((mapi(i), mape(j)),
   esv0 = sam(i,j); sam(i,j)=0;);
loop((mape(i), mapg(j)),
   eg0 = sam(i,j); sam(i,j)=0;);

*Extraction of other saving-related data from SAM:

parameter

gsv0  Government saving
fsv0(r)  Foreign saving;

loop((mapi(i), mapg(j)),
   gsv0 = sam(i,j); sam(i,j)=0;);
loop((mapi(i), mapx(j,r)),
   fsv0(r) = sam(i,j); sam(i,j)=0;);

*Extraction of other tax-related data from SAM:

parameter

tr0(t)  Tax revenue;

loop((mapg(i), mapt(j,t)),
   tr0(t) = sam(i,j); sam(i,j)=0;);

*Check if all values have been extracted from SAM:

display "All values should be zero if all data has been read: ", sam;

display ca0,fa0,ta0,iah0,ac0,iac0,
    mc0,tc0,rc0,cm0,gd0,er0,cs0,ch0,
    hf0,ef0,
    tp0,he0,hg0,hr0,hsv0,
    te0,ge0,xe0,esv0,eg0,
    gsv0,fsv0,
    tr0;

*Introduction of tax and trade-related data:

table regtm(r,g) tariff revenue by country of origin and good
Appendix C

<table>
<thead>
<tr>
<th></th>
<th>AGRI</th>
<th>MIN</th>
<th>MAN</th>
<th>SERV</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>0.007</td>
<td>0.001</td>
<td>0.618</td>
<td></td>
</tr>
<tr>
<td>ROSADC</td>
<td>0.001</td>
<td>0</td>
<td>0.084</td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td>0.040</td>
<td>0.004</td>
<td>1.382</td>
<td></td>
</tr>
</tbody>
</table>

\[\] table regvatb(r,g) vat collected at borders by country of origin and good

<table>
<thead>
<tr>
<th></th>
<th>AGRI</th>
<th>MIN</th>
<th>MAN</th>
<th>SERV</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.004</td>
<td>1.110</td>
<td>0.065</td>
</tr>
<tr>
<td>ROSADC</td>
<td>0.003</td>
<td>0</td>
<td>0.151</td>
<td>0.004</td>
</tr>
<tr>
<td>ROW</td>
<td>0.059</td>
<td>0.016</td>
<td>2.481</td>
<td>1.374</td>
</tr>
</tbody>
</table>

\[\]

parameter

\[
\begin{align*}
\text{mtx0}(r,g) &= \text{regtm}(r,g); \\
\text{vtx0}(r,g) &= \text{regvatb}(r,g); \\
\text{tm0}(g,r)$rc0(r,g) &= \frac{\text{mtx0}(r,g)}{rc0(r,g)}; \\
\text{vtb0}(g,r)$rc0(r,g) &= \frac{\text{vtx0}(r,g)}{(1+\text{tm0}(g,r))rc0(r,g)};
\end{align*}
\]

display
\[\text{mtx0, vtx0, tm0, vtb0};\]

*Manipulation of extracted values from SAM:

parameter

\[
\begin{align*}
\text{at0}(s) &= \text{activity tax (subsidies),} \\
\text{rebt0}(s) &= \text{vat rebate (on intermediate uses),} \\
\text{st0}(g) &= \text{sales tax,} \\
\text{vtd0}(g) &= \text{vat collected on domestic sold commodities entering Armington supply,} \\
\text{th0}(h) &= \text{household tax rate (on income from wages capital dividends and transfers),} \\
\text{et0} &= \text{enterprise tax rate (on income from capital and transfers),} \\
\text{as0}(g) &= \text{total Armington supply,} \\
\text{ex0}(r,g) &= \text{exports of good G at producer price for region R,} \\
\text{dm0}(g) &= \text{domestic uses,} \\
\text{ya0}(g) &= \text{aggregate output from all sectors,} \\
\text{c0}(h) &= \text{total household consumption (own + marketed),} \\
\text{ter0}(g) &= \text{total exports of good G,} \\
\text{tex0}(r) &= \text{total exports to region R,} \\
\text{mrge0}(g,r) &= \text{export margin by country of destination and good}
\end{align*}
\]
Appendix C

ter0(g) = sum(r, er0(g,r));

mrge0(g,r) = mc0("TME",g)*(er0(g,r)/ter0(g));
ex0(r,g) = er0(g,r) - mrge0(g,r);
tex0(r) = sum(g, ex0(r,g));

ya0(g) = max(sum(s, ac0(s,g)), ter0(g));
dm0(g) = ya0(g) - (sum(r, ex0(r,g)));

at0(s) = ta0("ATAX",s)/sum(g,ac0(s,g));
rebt0(s) = ta0("REB",s)/sum(g,ca0(g,s));
vtd0(g) = tc0("VATD",g)/dm0(g);

th0(h) = tp0("YTAX",h)/(sum(f,hf0(h,f)) + he0(h) + hg0(h) + (sum(r,hr0(h,r))));
et0 = te0("YTAX")/(sum(f,ef0(f)) + eg0);

as0(g) = sum(r,rc0(r,g)) + sum(t,tc0(t,g)) + mc0("TMD",g) + mc0("TMM",g) + dm0(g);
st0(g) = tc0("STAX",g)/as0(g);
c0(h) = sum(g, ch0(g,h)) + sum(is, iah0(is,h));

*Introduction of trade elasticities:

table elasticity(*,*) elasticities in CES and CET functions

<table>
<thead>
<tr>
<th></th>
<th>sigmaQ</th>
<th>sigmaT</th>
<th>RELASARM</th>
<th>RELACET</th>
</tr>
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<tbody>
<tr>
<td>AGRI</td>
<td>2.1</td>
<td>2.1</td>
<td>5.8</td>
<td>5.8</td>
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<td>MIN</td>
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<td>3.1</td>
<td>13.2</td>
<td>13.2</td>
</tr>
<tr>
<td>MAN</td>
<td>2.6</td>
<td>2.6</td>
<td>6.7</td>
<td>6.7</td>
</tr>
<tr>
<td>TRADE</td>
<td>1.9</td>
<td>1.9</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>SERV</td>
<td>2.1</td>
<td>2.1</td>
<td>3.9</td>
<td>3.9</td>
</tr>
</tbody>
</table>

parameter

py0(s) Reference price of final activity products gross of activity tax,

py0(s) = 1-at0(s);

pa0(g,s) Reference price of intermediate uses gross of VAT rebate;

pa0(g,s) = 1+rebt0(s);

*Introduction of trade elasticities:

table elasticity(*,*) elasticities in CES and CET functions

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</tr>
</tbody>
</table>

parameter

sigmaQ(s) Elasticity of substitution between imports and domestic uses,

sigmaT(s) Elasticity of transformation between exports and domestic uses,

relasarm(s) Elasticity of substitution among imports from different origins,

relacet(s) Elasticity of transformation among exports to different destinations;

sigmaQ(s) = elasticity(s,"sigmaQ");
sigmaT(s) = elasticity(s,"sigmaT");
relasarm(s) = elasticity(s,"relasarm");
relacet(s) = elasticity(s, "relacet");

$ontext
$model:moz

$sectors:
x(s)                          !allocation of output to domestic and export markets
y(s)                          !sectoral output (domestic production) for formal sectors
iy(is)$iac0(is)               !sectoral output (domestic production) for informal sectors
es(r)$tex0(r)                 !export activity (applies margins) per destination
a(s)                          !aggregate supply (armington aggregate)
mg                            !transport margins
c(h)                          !household consumption
gd                            !government consumption
invest                        !aggregate investment

$commodities:
py(g)                         !output price for formal sectors
ply(is)$iac0(is)              !output price for informal sectors
dm0(g)                        !domestic sales price
ex0(r,g)                      !export price
px(r,g)$ex0(r,g)              !export price
ps(g)                         !composite demand price for marketed output
pc(h)                         !household consumption price
pt                            !trade and transportation margins
pf(f)                         !factor prices
pg                            !government consumption price
pe                            !enterprise rents
px(r)                        !price of foreign exchange
pinv                          !price of investments
ptran                         !price of social transfers

$consumers:
ra(h)                         !private households
entr                          !private firms
govt                          !government
foreign(r)                    !foreigners

$auxiliary:
fsav(r)      !scaling parameter for foreign savings from region r
gsav         !scaling parameter for government savings

*Sectoral production combines primary factors and intermediates. the first sector
*produces market output and pays taxes, the second produces non-market output.

$prod:y(s)      s:0  va:0.5
o:py(g)         q:ac0(s,g)        a:govt  t:(at0(s))  p:py0(s)
Commodity supply to domestic and export markets is modelled as a constant elasticity of transformation function:

\[ \text{prod} : x(g) \quad \text{td: relacet}(g) \quad t(\text{td}): \sigma_T(g) \]

Domestic production for export markets (at producer price) is decomposed into exports for different destinations (at final prices applying margins):

\[ \text{prod} : \text{es}(r) \quad \text{tex0}(r) \]

Production of marketing and transportation services:

\[ \text{prod} : \text{mg} \quad s: 0 \]

Supply of Armington composite supply involves collection of import duties and other indirect taxes, the application of distribution margins:

\[ \text{prod} : a(g) \quad \text{ddm: relasarm}(g) \quad \text{dm}(\text{ddm}): \sigma_Q(g) \quad d: 0 \quad m(\text{dm}): 0 \]

Investment demand:

\[ \text{prod: invest} \]

Household demand for market and non-market goods and services:
Appendix C

$\text{prod}: c(h)
\begin{align*}
o: pc(h) & \quad q: (\text{sum}(g, ch0(g,h)) + \text{sum}(is, iah0(is,h))) \\
i: pa(g) & \quad q: ch0(g,h) \\
i: piy(is) & \quad q: iah0(is,h)
\end{align*}

*Government demand:
$\text{prod}: gd
\begin{align*}
o: pg & \quad q: (\text{sum}(g, gd0(g))) \\
i: pa(g) & \quad q: gd0(g)
\end{align*}

*Household income and expenditures:
$\text{demand}: ra(h)
\begin{align*}
d: pc(h) & \quad q: c0(h) \\
e: pf("l") & \quad q: (hf0(h, "l") * (1 - th(h))) & \text{labour income net of tax} \\
e: pf("k") & \quad q: (hf0(h, "k") * (1 - th(h))) & \text{capital income net of tax} \\
e: pfx(r) & \quad q: (hr0(h,r) * (1 - th(h))) & \text{remittances net of tax} \\
e: pnv & \quad q: (-hsv0(h)) & \text{private savings} \\
e: pe & \quad q: (he0(h) * (1 - th(h))) & \text{distributed profits net of tax} \\
e: ptran & \quad q: (hg0(h) * (1 - th(h))) & \text{social transfers net of tax}
\end{align*}

*Enterprise income and expenditures:
$\text{demand}: entr
\begin{align*}
d: pe & \quad q: (\text{sum}(h, he0(h)) + ge0) \\
e: pf("k") & \quad q: (ef0("k") * (1 - et0)) & \text{capital income net of tax} \\
e: pfx(r) & \quad q: (-xe0(r)) & \text{payments to foreigners} \\
e: ptran & \quad q: (eg0 * (1 - et0)) & \text{social transfers net of tax} \\
e: pnv & \quad q: (-betaz) * (\text{sum}(g, cs0(g)))) & \text{enterprise savings}
\end{align*}

*Government income and expenditures:
$\text{demand}: govt
\begin{align*}
d: pg & \quad q: (\text{sum}(g, gd0(g))) \\
e: pnv & \quad q: (-gsv0) & \text{government savings} \\
e: ptran & \quad q: (-eg0 + \text{sum}(h, hg0(h))) & \text{social transfers} \\
e: pe & \quad q: ge0 & \text{distributed profits} \\
e: pf("k") & \quad q: (\text{sum}(h, (hf0("k", h) * (th0(h)))))) & \text{tax on enterprise capital} \\
e: pf("l") & \quad q: (\text{sum}(h, (hf0("L", h) * (th0(h)))))) & \text{tax on household labour} \\
e: pfx(r) & \quad q: (\text{sum}(h, (hr0(h,r) * (th0(h)))))) & \text{tax on household remittances} \\
e: pe & \quad q: (\text{sum}(h, (he0(h) * (th0(h)))))) & \text{tax on household distributed profits} \\
e: ptran & \quad q: (\text{sum}(h, hg0(h) * (th0(h)))) & \text{tax on household social transfers} \\
e: pf("k") & \quad q: (ef0("k") * (et0)) & \text{tax on enterprise capital}
\end{align*}
Appendix C

\[ e_{\text{ptran}} \quad q: (eg0 \cdot (et0)) \quad !\text{tax on enterprise social transfers} \]

*Foreigners’ income and expenditures:

\$ \text{demand: foreign}(r) \$

\[ d_{\text{pfx}}(r) \quad q: (\text{sum}(g, er0(g, r))) \]

\[ e_{\text{pinv}} \quad q: (-fsv0(r)) \quad r: \text{fsav}(r) \quad !\text{foreign savings} \]

\[ e_{\text{pfx}}(r) \quad q: (xe0(r)) \quad !\text{enterprise payments to foreigners} \]

\[ e_{\text{pfx}}(r) \quad q: (-\text{sum}(h, hr0(h, r))) \quad !\text{household remittances} \]

\[ e_{\text{pfx}}(r) \quad q: (\text{sum}(g, rc0(r, g))) \quad !\text{imports} \]

*Complementarity condition for the scaling parameter fsav:

\$ \text{constraint: fsav}(r) \$

\[ \text{fsav}(r) \cdot fsv0(r) \cdot \text{pinv} = e = \text{pfx}(r) \cdot ((\text{sum}(g, rc0(r, g))) - \text{sum}(g, er0(g, r))) + (xe0(r)) - \text{sum}(h, hr0(h, r))) ; \]

*Complementarity condition for the scaling parameter gsav:

\$ \text{constraint: gsav} \$

\[ \text{govt/pg} = e = (\text{sum}(g, gd0(g))) ; \]

\$ \text{report}: \$

\[ v: \text{formprod}(s, g) \quad o: py(g) \quad \text{prod}: y(s) \]

\[ v: \text{inforprod}(is) \quad o: piy(is) \quad \text{prod}: iy(is) \]

\[ v: \text{import}(r, g) \quad i: \text{pfx}(r) \quad \text{prod}: a(g) \]

\[ v: \text{export}(r, g) \quad o: \text{px}(r, g) \quad \text{prod}: x(g) \]

\[ v: \text{exportfp}(r) \quad o: \text{pfx}(r) \quad \text{prod}: es(r) \]

\[ v: \text{domuses}(g) \quad o: \text{pd}(g) \quad \text{prod}: x(g) \]

\[ v: \text{margins} \quad o: \text{pt} \quad \text{prod}: mg \]

\[ v: \text{intermed}(g, s) \quad i: \text{pa}(g) \quad \text{prod}: y(s) \]

\[ v: \text{factdeminf}(f, is) \quad i: \text{pf}(f) \quad \text{prod}: iy(is) \]

\[ v: \text{factdem}(f, s) \quad i: \text{pf}(f) \quad \text{prod}: y(s) \]

\[ v: \text{armington}(g) \quad o: \text{pa}(g) \quad \text{prod}: a(g) \]

\[ v: \text{rinvest} \quad o: \text{pinv} \quad \text{prod}: \text{invest} \]

\[ v: \text{rcons}(h) \quad o: \text{pc}(h) \quad \text{prod}: c(h) \]

\[ v: \text{rgovt} \quad o: \text{pg} \quad \text{prod}: \text{gd} \]

\[ v: \text{renter} \quad d: \text{pe} \quad \text{demand}: \text{entr} \]

\$ \text{offtext} \$

\$ \text{sysinclude mpsgeset moz} \$

*Initialization of the scaling parameters and choice of the appropriate closure rule.
km.L=1;

*If the closure rule is EXOGENOUS foreign savings put an asterix before these commands:
fsav.L(r)=1;
fsav.LO(r)= -inf;

**If the closure rule is ENDOGENOUS foreign savings put an asterix before the command:
fsav.FX(r)=1;

*If the closure rule is EXOGENOUS governmemnt savings put an asterix before these commands:
gsav.L=1;
gsav.LO=-inf;

*If the closure rule is ENDOGENOUS government savings put an asterix before the command:
gsav.FX=1;

$include moz.gen
solve moz using mcp;

*Counterfactual: trade liberalization in the SADC area:

tm0(g,"rsa") = 0;
tm0(g,"rosadc") =0;

$include moz.gen
solve moz using mcp;
## Appendix D: The “Bastard Keynesian” CGE Model Specifications

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<td>$\sigma_T(s)$</td>
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<td>$relacet(s)$</td>
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<tr>
<td>$\sigma_Q(s)$</td>
<td>$\sigma^Q_s$</td>
<td>Elasticity of substitution between domestic uses and imports of sector $s$</td>
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<td>$relasarm(s)$</td>
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<td>$mrge0(g, r)$</td>
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#### Production

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<td>$X(s)$</td>
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<td>$Y(s)$</td>
<td>Domestic total production (exports + domestic uses) in sector $s$</td>
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#### Factors

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<td>Factor $f$ demand in activity $s$</td>
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<td>$HE0(h)$</td>
<td>Household $h$ distributed profits</td>
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<tr>
<td>$HG0(h)$</td>
<td>Household $h$ social transfers</td>
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<tr>
<td>$TP0(“YTAX”,h)$</td>
<td>Household $h$ income tax</td>
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### Variable Definitions

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<td>Enterprise savings</td>
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<td>EG0</td>
<td>Enterprise social transfers</td>
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### Scaling Parameters

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<td>gsav</td>
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Appendix E: The GAMS/MPSGE Code for the “Bastard Keynesian” Model

$TITLE A "Bastard Keynesian" CGE model for Mozambique

$context
This model was developed to assess the impact of the Mozambican participation into the Southern Africa Development Community (SADC). This code is part of the Ph.D. thesis "The Mozambican Participation in SADC- A Liberalization Process trough Different Models and Different Closures".
The study was conducted by Elisa Delpiazzo, under the supervision of Prof. Marco Missaglia, University of Pavia. The analysis uses a GAMS/MPSGE CGE model based on the 2003 Mozambique SAM. The focus of the study is on examining the impact of a tariff reduction as the one scheduled in the SADC Trade Protocol.

$offtext

set colorder /chk/;

set i SAM rows and column indices   /1*35/;

*SAM rows and columns are the same set:

alias (i,j);

table sam(i,j)  Base year social accounts

*Call the SAM from the worksheet in Excel format and import it in GAMS:

$call=xls2gms  i=bksam.xls   o=bksam.inc
$include bksam.inc
;

*Computation works best when features are around unit, so we scale the SAM values:

sam(i,j)        = sam(i,j)/1000;

display sam;

*Check the consistency of the SAM and report negative values and empty rows or columns:

parameter       samchk  Check of SAM consistency;

samchk(i) = (sum(j, sam(i,j)-sam(j,i)));

display samchk;

set  negval(i,j)   flag for negative elements;

negval(i,j) = yes$(sam(i,j)<0);
display negval;

set empty(i, *) flag for empty rows and columns;
empty(i, "row") = 1$(sum(j, sam(i,j)) = 0);
empty(j, "col") = 1$(sum(i, sam(i,j)) = 0);

display empty;

*Declare sets with which the SAM should be relabeled:

set s List of formal activities and commodities/
  AGRI agriculture fishing forestry and breeding activities,
  MIN mining,
  MAN industry (food processing and beverages light and heavy
  manufacturing metal products),
  TRADE wholesales and retail trade,
  SERV services/,

is List of informal activities and commodities/
  INF-AGRI agriculture fishing forestry and breeding activities,
  INF-MIN mining,
  INF-MAN industry (food processing and beverages light and heavy
  manufacturing metal products),
  INF-TRADE wholesales and retail trade,
  INF-SERV services/,

m Margins/
  TMD domestic sales transactions costs,
  TMM import transactions costs,
  TME export transactions costs/,

f Factors of production/
  L labour,
  K capital/,

h Household /
  RHHDS rural households
  UHHDS urban households/,

e Enterprise /ENTR/,

t Taxes/
  ATAX Activity tax (subsidy),
  REB Vat rebate (on intermediate uses),
  YTAX Income tax (for households and private firms),
  VATB VAT tax collected at borders (on imports gross of tariffs),
Appendix E

VATD    VAT tax collected on domestic sales,
STAX    Sales tax,
MTAX    Import tax,

r Regions/
  RSA    Republic of South Africa,
  ROSADC Rest of SADC,
  ROW    Rest of World/

alias (i,j), (s,g), (is,ig), (m,mm);

*Mapping the activities:

Set mapa(i,s) Mapping from SAM to formal activities/
  1.AGRI,
  2.MIN,
  3.MAN,
  4.TRADE,
  5.SERV /

mapia(i,is) Mapping from SAM to informal activities/
  6.INF-AGRI,
  7.INF-MIN,
  8.INF-MAN,
  9.INF-TRADE,
  10.INF-SERV /

mapc(i,g) Mapping from SAM to commodities/
  11.AGRI,
  12.MIN,
  13.MAN,
  14.TRADE,
  15.SERV /

mapf(i,f) Mapping from SAM to factors of production /
  16.L,
  17.K /

mapm(i,m) Mapping from SAM to marketing margins /
  18.TMD,
  19.TMM,
  20.TME /

maph(i,h) Mapping from SAM to households /
  21.RHHDS,
  22.UHHDS/,
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mape(i) Mapping from SAM to enterprise account /23/,

mapg(i) Identifying government row /24/,

mapt(i,t) Mapping from SAM to source of taxes /25.REB,
26.ATAX,
27.VATD,
28.VATB,
29.MTAX,
30.STAX,
31.YTAX /

mapi(i) Identifying the investment and saving row /32/,

mapx(i,r) Mapping from SAM to the rest of the world /33.RSA,
34.ROSADC,
35.ROW /

set ss/a, ia, c, m, f, e, h, g, t, x, i/

*Generate a report of submatrix totals:

parameter totals(*,*) SAM totals for reporting;
totals("a","c") = sum((mapa(i,s), mapc(j,g)), sam(i,j));
totals("ia","h") = sum((mapia(i,is), maph(j,h)), sam(i,j));
totals("c","a") = sum((mapc(i,g), mapa(j,s)), sam(i,j));
totals("c","ia") = sum((mapc(i,g), mapia(j,is)), sam(i,j));
totals("c","m") = sum((mapc(i,g), mapm(j,m)), sam(i,j));
totals("c","h") = sum((mapc(i,g), maph(j,h)), sam(i,j));
totals("c","x") = sum((mapc(i,g), mapx(j,r)), sam(i,j));
totals("c","i") = sum((mapc(i,g), mapi(j)), sam(i,j));
totals("m","c") = sum((mapm(i,m), mapc(j,g)), sam(i,j));
totals("f","a") = sum((mapf(i,f), mapa(j,s)), sam(i,j));
totals("f","ia") = sum((mapf(i,f), mapia(j,is)), sam(i,j));
totals("e","f") = sum((mape(i), mapf(j,f)), sam(i,j));
totals("e","g") = sum((mape(i), mapg(j)), sam(i,j));
totals("h","f") = sum((maph(i,h), mapf(j,f)), sam(i,j));
totals("h","e") = sum((maph(i,h), mape(j)), sam(i,j));
totals("h","g") = sum((maph(i,h), mapg(j)), sam(i,j));
totals("h","x") = sum((maph(i,h), mapx(j,r)), sam(i,j));
totals("g","e") = sum((mapg(i), mape(j)), sam(i,j));
totals("g","t") = sum((mapg(i), mapt(j,t)), sam(i,j));
totals("t","a") = sum((mapt(i,t), mapa(j,s)), sam(i,j));
totals("t","c") = sum((mapt(i,t), mapc(j,g)), sam(i,j));

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Appendix E

totals("t","e") = sum((mapt(i,t), mape(j)), sam(i,j));  
totals("t","h") = sum((mapt(i,t), maph(j,h)), sam(i,j));  
totals("x","c") = sum((mapx(i,r), mapc(j,g)), sam(i,j));  
totals("x","e") = sum((mapx(i,r), mape(j)), sam(i,j));  
totals("i","e") = sum((mapi(i), mape(j)), sam(i,j));  
totals("i","h") = sum((mapi(i), maph(j,h)), sam(i,j));  
totals("i","g") = sum((mapi(i), mapg(j)), sam(i,j));  
totals("i","x") = sum((mapi(i), mapx(j,r)), sam(i,j));  
alias (ss,sss);  
totals(ss,"total") = sum(sss, totals(ss,sss));  
totals("total",ss) = sum(sss, totals(sss,ss));  
option totals:1;  
display totals;  

*Extract sub-matrices from the SAM. When a sub-matrix is extracted the associated values in the original SAM are set equal to zero.

*Extraction of domestic production-related data from SAM:

Parameter  
ca0(g,s) Intermediate inputs demand for formal sectors,  
cia0(g,is) Intermediate input demand for informal sectors,  
fa0(f,s) Factor demand (or value added) for formal sectors,  
fia0(f,is) Factor demand (or value added) for informal sectors,  
ta0(t,s) Tax collection,  
iah0(is,h) Household consumption of own production,  
ac0(s,g) Marketed output,  
iac0(is) production of informal sectors;

loop((mapc(i,g), mapa(j,s)), ca0(g,s) = sam(i,j); sam(i,j)=0;);  
loop((mapc(i,g), mapia(j,is)), cia0(g,is) = sam(i,j); sam(i,j)=0;);  
loop((mapf(i,f), mapa(j,s)), fa0(f,s) = sam(i,j); sam(i,j)=0;);  
loop((mapf(i,f), mapia(j,is)), fia0(f,is) = sam(i,j); sam(i,j)=0;);  
loop((mapt(i,t), mapa(j,s)), ta0(t,s) = sam(i,j); sam(i,j)=0;);  
loop((mapia(i,is), maph(j,h)), iah0(is,h) = sam(i,j); sam(i,j)=0;);  
loop((mapa(i,s), mapc(j,g)), ac0(s,g) = sam(i,j); sam(i,j)=0;);  

iac0(is) = sum(h,iah0(is,h));  

*Extraction of commodity demand components from SAM:

Parameter  
mc0(m,g) Marketing and transportation costs,  
tc0(t,g) Indirect taxes,
rc0(r,g)        Value of imports at cif price, 

cm0(g,m)        Sales to wholesale and retail margins, 

gd0(g)          Government demand, 

er0(g,r)        Export (fob), 

cs0(g)          Investment demand, 

ch0(g,h)        Private consumption;

loop((mapm(i,m), mapc(j,g)),    mc0(m,g) = sam(i,j); sam(i,j)=0;); 

loop((mapt(i,t), mapc(j,g)),    tc0(t,g) = sam(i,j); sam(i,j)=0;); 

loop((mapx(i,r), mapc(j,g)),    rc0(r,g) = sam(i,j); sam(i,j)=0;); 

loop((mapc(i,g), mapm(j,m)),    cm0(g,m) = sam(i,j); sam(i,j)=0;); 

loop((mapc(i,g), mapg(j)),      gd0(g) = sam(i,j); sam(i,j)=0;); 

loop((mapc(i,g), mapx(j,r)),    er0(g,r) = sam(i,j); sam(i,j)=0;); 

loop((mapc(i,g), mapi(j)),      cs0(g) = sam(i,j); sam(i,j)=0;); 

loop((mapc(i,g), maph(j,h)),    ch0(g,h) = sam(i,j); sam(i,j)=0;); 

*Extraction of factor- related data from SAM:

parameter 

hf0(f,h)    Factors income to households, 

ef0(f)      Factors income to enterprises;

loop((maph(i,h), mapf(j,f)),      hf0(f,h) = sam(i,j); sam(i,j)=0;); 

loop((mape(i), mapf(j,f)),        ef0(f) = sam(i,j); sam(i,j)=0;); 

*Extraction of household- related data from SAM:

parameter 

tp0(t,h)     Income tax payment by households 

he0(h)      Enterprise payment to households 

hg0(h)      Government transfer to households 

hr0(h,r)    Household income from abroad 

hsv0(h)     Household savings;

loop((mapt(i,t), maph(j,h)),       tp0(t,h) = sam(i,j); sam(i,j)=0;); 

loop((maph(i,h), mape(j)),        he0(h) = sam(i,j); sam(i,j)=0;); 

loop((maph(i,h), mapg(j)),       hg0(h) = sam(i,j); sam(i,j)=0;); 

loop((maph(i,h), mapx(j,r)),     hr0(h,r) = sam(i,j); sam(i,j)=0;); 

loop((mapi(i), maph(j,h)),       hsv0(h) = sam(i,j); sam(i,j)=0;); 

*Extraction of enterprise- related data from SAM:

parameter 

te0(t)       Enterprise direct taxes 

ge0         Enterprise dividends paid to Government 

xe0(r)       Enterprise payments to foreigners 

esv0        Enterprise savings 

eg0         Government transfers to enterprise;
*Extraction of other saving-related data from SAM:

parameter
    gsv0       Government saving
    fsv0(r)    Foreign saving;

loop((mapi(i), mapg(j)),   gsv0 = sam(i,j); sam(i,j)=0;);
loop((mapi(i), mapx(j,r)),  fsv0(r) = sam(i,j); sam(i,j)=0;);

*Extraction of other tax-related data from SAM:

parameter
    tr0(t)     Tax revenue;

loop((mapg(i), mapj(t)),   tr0(t) = sam(i,j); sam(i,j)=0;);

*Check if all values have been extracted from SAM:

display "All values should be zero if all data has been read:", sam;

display ca0, fa0, ta0, iah0, ac0, iac0,
    mc0, tc0, rc0, cm0, gd0, er0, cs0, ch0,
    hf0, ef0,
    tp0, he0, hg0, hr0, hsv0,
    te0, ge0, xe0, esv0, eg0,
    gsv0, fsv0,
    tr0;

*Introduction of tax- and trade-related data:

table regtm(r,g) tariff revenue by country of origin and good

<table>
<thead>
<tr>
<th></th>
<th>AGRI</th>
<th>MIN</th>
<th>MAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>0.007</td>
<td>0</td>
<td>0.619</td>
</tr>
<tr>
<td>ROSADC</td>
<td>0.001</td>
<td>0</td>
<td>0.084</td>
</tr>
<tr>
<td>ROW</td>
<td>0.040</td>
<td>0.005</td>
<td>1.381</td>
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;
Appendix E

<table>
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<th>MIN</th>
<th>MAN</th>
<th>SERV</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>0.022</td>
<td>0.004</td>
<td>1.110</td>
<td>0.065</td>
</tr>
<tr>
<td>ROSADC</td>
<td>0.003</td>
<td>0</td>
<td>0.151</td>
<td>0.004</td>
</tr>
<tr>
<td>ROW</td>
<td>0.059</td>
<td>0.016</td>
<td>2.481</td>
<td>1.374</td>
</tr>
</tbody>
</table>

\[
\text{parameter} \\
\text{mtx0}(r,g) \quad \text{total import duties on imports of good } g \text{ from region } r, \\
\text{tm0}(g,r) \quad \text{import tariff rate}, \\
\text{vtx0}(r,g) \quad \text{total vat collected at borders on good } g \text{ from region } r, \\
\text{vtb0}(g,r) \quad \text{vat rate collected at borders on imports entering Armington supply};
\]

\[
\begin{align*}
\text{mtx0}(r,g) & = \text{regtm}(r,g); \\
\text{vtx0}(r,g) & = \text{regvatb}(r,g); \\
\text{tm0}(g,r)$rc0(r,g) & = \text{mtx0}(r,g)/\text{rc0}(r,g); \\
\text{vtb0}(g,r)$rc0(r,g) & = \text{vtx0}(r,g)/((1+\text{tm0}(g,r))*\text{rc0}(r,g));
\end{align*}
\]

\[
\text{display} \\
\text{mtx0, vtx0, tm0, vtb0};
\]

*Manipulation of extracted values from SAM:

\[
\text{parameter} \\
\begin{align*}
\text{at0}(s) & \quad \text{activity tax (subsidies)}, \\
\text{rebt0}(s) & \quad \text{vat rebate (on intermediate uses)}, \\
\text{st0}(g) & \quad \text{sales tax}, \\
\text{vtd0}(g) & \quad \text{vat collected on domestic sold commodities entering Armington supply}, \\
\text{th0}(h) & \quad \text{household tax rate (on income from wages capital dividends and transfers),} \\
\text{et0} & \quad \text{enterprise tax rate (on income from capital and transfers),} \\
\text{as0}(g) & \quad \text{total Armington supply}, \\
\text{ex0}(r,g) & \quad \text{exports of good } G \text{ at producer price for region } R, \\
\text{dm0}(g) & \quad \text{domestic uses}, \\
\text{ya0}(g) & \quad \text{aggregate output from all sectors}, \\
\text{c0}(h) & \quad \text{total household consumption (own + marketed),} \\
\text{ter0}(g) & \quad \text{total exports of good } G, \\
\text{tex0}(r) & \quad \text{total exports to region } R, \\
\text{mrge0}(g,r) & \quad \text{export margin by country of destination and good}, \\
\text{alphaz}(h) & \quad \text{household } h \text{ share on total investments}, \\
\text{betaz} & \quad \text{enterprise share in total investments}, \\
\text{sr}(h) & \quad \text{saving propensity for household } h
\end{align*}
\]

\[
\text{ter0}(g) = \text{sum}(r, \text{er0}(g,r)); \\
\text{mrge0}(g,r)$\text{er0}(g,r) & = \text{mc0}("TME",g)*(\text{er0}(g,r)/\text{ter0}(g)); \\
\text{ex0}(r,g) & = \text{er0}(g,r) - \text{mrge0}(g,r); \\
\text{tex0}(r) & = \text{sum}(g, \text{ex0}(r,g));
\]
Appendix E

\[
y_{a0}(g) = \max(\sum(s, ac_{0}(s,g)), ter_{0}(g));
\]
\[
dm_{0}(g) = y_{a0}(g) - (\sum(r, ex_{0}(r,g)));
\]
\[
at_{0}(s)\text{($not\sum(g,ac_{0}(s,g))=0$)} = ta_{0}("ATAX",s)/\sum(g,ac_{0}(s,g));
\]
\[
reb_{0}(s)\text{($not\sum(g,ca_{0}(g,s))=0$)} = ta_{0}("REB",s)/\sum(g,ca_{0}(g,s));
\]
\[
vtd_{0}(g)\text{$dm_{0}(g)$} = tc_{0}("VATD",g)/dm_{0}(g);
\]
\[
th_{0}(h) = tp_{0}("YTAX",h)/\sum(f,hf_{0}(f,h)) + he_{0}(h) + hg_{0}(h) + (\sum(r,hr_{0}(h,r)));
\]
\[
et_{0} = te_{0}("YTAX")/(\sum(f,ef_{0}(f)) + eg_{0});
\]
\[
as_{0}(g) = \sum(r,rc_{0}(r,g)) + \sum(t,tc_{0}(t,g)) + mc_{0}("TMD",g) + mc_{0}("TMM",g) + dm_{0}(g);
\]
\[
st_{0}(g)\text{$as_{0}(g)$} = tc_{0}("STAX",g)/as_{0}(g);
\]
\[
c_{0}(h) = \sum(g, ch_{0}(g,h)) + \sum(is, iah_{0}(is,h));
\]
\[
alphaz(h) = hsv_{0}(h)/\sum(g, cs_{0}(g));
\]
\[
betaz = esv_{0}/\sum(g, cs_{0}(g));
\]
\[
sr(h) = hsv_{0}(h)/((1-th_{0}(h))*\sum(f,hf_{0}(f,h)) + he_{0}(h) + hg_{0}(h) + (\sum(r,hr_{0}(h,r))));
\]
\[
display\ at_{0}, reb_{0}, vtd_{0}, th_{0}, et_{0}, as_{0}, st_{0}, ex_{0}, ya_{0}, dm_{0}, ter_{0}, tex_{0}, mrge_{0}, c_{0},
\]
\[
alphaz, betaz, sr;
\]
\[
\text{parameter}\ py_{0}(s)\quad \text{Reference price for final activity products gross of activity tax},
\]
\[
pa_{0}(g,s)\quad \text{Reference price of intermediate uses gross of VAT rebate};
\]
\[
py_{0}(s) = 1-at_{0}(s);
\]
\[
pa_{0}(g,s) = 1+reb_{0}(s);
\]
\[
*\text{Introduction of trade elasticities:}
\]
\[
\begin{tabular}{|c|c|c|c|c|}
\hline
& sigmaQ & sigmaT & RELASARM & RELACET \\
\hline
AGRI & 2.1 & 2.1 & 5.8 & 5.8 \\
\hline
MIN & 3.1 & 3.1 & 13.2 & 13.2 \\
\hline
MAN & 2.6 & 2.6 & 6.7 & 6.7 \\
\hline
TRADE & 1.9 & 1.9 & 3.8 & 3.8 \\
\hline
SERV & 2.1 & 2.1 & 3.9 & 3.9 \\
\hline
\end{tabular}
\]
\[
;\]
\[
\text{parameter}\ sigmaQ(s)\quad \text{Elasticity of substitution between imports and domestic uses},
\]
\[
sigmaT(s)\quad \text{Elasticity of transformation between exports and domestic uses},
\]
\[
relasarm(s)\quad \text{Elasticity of substitution among imports from different origins},
\]
\[
relacet(s)\quad \text{Elasticity of transformation among exports to different destinations}
\]
\[
;\]
\[
sigmaQ(s) = \text{elasticity}(s," sigmaQ");
\]
\[
sigmaT(s) = \text{elasticity}(s," sigmaT");
\]
\[
relasarm(s) = \text{elasticity}(s," relasarm");
\]
Appendix E

relacet(s) = elasticity(s, "relacet");

$ontext
$model:moz

$sectors:
x(s) !allocation of output to domestic and export markets
y(s) !sectoral output (domestic production) for formal sectors
iy(is)$iac0(is) !sectoral output (domestic production) for informal sectors
es(r)$tex0(r) !export activity (applies margins) per destination
a(s) !aggregate supply (armington aggregate)
mg !transport margins
c(h) !household consumption
gd !government consumption
invest !aggregate investments

$commodities:
py(g) !output price for formal sectors
piy(is)$iac0(is) !output price for informal sectors
pd(g)$dm0(g) !domestic sales price
px(r,g)$ex0(r,g) !export price
pa(g) !composite demand price for marketed output
pc(h) !household consumption price
pt !trade and transportation margins
pf(f) !factor prices
pg !government consumption price
pe !enterprise rents
pfx(r) !price of foreign exchange
pinv !price of investments
ptran !price of social transfers

$consumers:
ra(h) !private households
entr !private firms
govt !government
foreign(r) !foreigners

$auxiliary:
Km !Keynesian multiplier
fsav(r) !scaling parameter for foreign savings from region r
gsav !scaling parameter for government savings

*Sectoral production combines primary factors and intermediates. The first sector
*produces market output ad pays taxes, the second produces non-market output.

$prod:y(s) s:0 va:0.5
o:py(g) q:ac0(s,g) a:govt t:(at0(s)) p:py0(s)
Appendix E

Commodity supply to domestic and export markets is modelled as a constant elasticity of transformation function:

\[ \text{prod}: x(g) \quad t: \sigma T(g) \quad tt(t): \text{relacet}(g) \]

Domestic production for export markets (at producer price) is decomposed into exports for different destinations (at final prices applying margins):

\[ \text{prod}: \text{es}(r) \text{tex}(r) \]

Production of marketing and transportation services:

\[ \text{prod}: \text{mg} \quad s: 0 \]

Supply of Armington composite supply involves collection of import duties and other indirect taxes, the application of distribution margins:

\[ \text{prod}: a(g) \quad \text{ddm}: \text{relasarm}(g) \quad \text{dm}(\text{ddm}): \sigma Q(g) \quad d: 0 \quad m(\text{dm}): 0 \]

Household demand for market and non-market goods and services:

\[ \text{prod}: c(h) \]

i:pa(g)         q:ca0(g,s)                        a:govt  t:(rebt0(s)) p:pa0(g,s)
i:pf(f)         q:fa0(f,s)  va:

$\text{prod}: \text{i}y(is) \text{iac}(is) \quad s:0 \quad va:0.5$

i:pa(g)         q:cia0(g,is)
i:pf(f)         q:fia0(f,is)  va:

*Commodity supply to domestic and export markets is modelled as a constant elasticity of transformation function:

$\text{prod}: x(g) \quad t: \sigma T(g) \quad tt(t): \text{relacet}(g)$

o:pd(g)         q:dm0(g)
o:px(r,g)       q:ex0(r,g)  tt:
i:py(g)         q:ya0(g)

*Domestic production for export markets (at producer price) is decomposed into exports for different destinations (at final prices applying margins):

$\text{prod}: \text{es}(r) \text{tex}(r)$

i:px(r,g)       q:ex0(r,g)
i:pt            q:(sum(g, mrge0(g,r)))

*Production of marketing and transportation services:

$\text{prod}: \text{mg} \quad s: 0$

i:pa(g)         q:(sum(m, cm0(g,m)))

*Supply of Armington composite supply involves collection of import duties and other indirect taxes, the application of distribution margins:

$\text{prod}: a(g) \quad \text{ddm}: \text{relasarm}(g) \quad \text{dm}(\text{ddm}): \sigma Q(g) \quad d: 0 \quad m(\text{dm}): 0$

i:pa(g)         q:as0(g)                        a:govt  t:st0(g)
i:pd(g)         q:dm0(g)                        a:govt  t:vtd0(g)
i:pt            q:mc0(\text{"TMD"}, g)  d:
i:pfx(r)        q:rc0(r,g)  m: \quad a:govt  t: (vtb0(g,r)+(tm0(g,r)*(1+vtb0(g,r))))
i:pt            q:mc0(\text{"TMM"}, g)  m:

*Household demand for market and non-market goods and services:

$\text{prod}: c(h)$

o:pc(h)         q:c0(h)
i:pa(g)         q:ch0(g,h)
i:piy(is)       q:iah0(is,h)
Appendix E

*Government demand:

$\text{prod:gd}$

\begin{align*}
o &: \text{pg} & q &: (\text{sum}(g, \text{gd0}(g))) \\
i &: \text{pa}(g) & q &: \text{gd0}(g)
\end{align*}

*Investment demand:

$\text{prod:invest}$

\begin{align*}
o &: \text{pinv} & q &: (\text{sum}(g, \text{cs0}(g))) \\
i &: \text{pa}(g) & q &: \text{cs0}(g)
\end{align*}

*Household income and expenditures:

$\text{demand:ra}(h)$

\begin{align*}
d &: \text{pc}(h) & q &: \text{c0}(h) \\
e &: \text{pf}("k") & q &: (\text{hf0}("k", h)*(1-\text{th0}(h))) & !\text{capital income net of tax} \\
e &: \text{pf}("l") & q &: (\text{hf0}("L", h)*(1-\text{th0}(h))) & !\text{labour income net of tax} \\
e &: \text{pfx}(r) & q &: (\text{hr0}(h, r)*(1-\text{th0}(h))) & !\text{remittances net of tax} \\
e &: \text{pe} & q &: (\text{he0}(h)*(1-\text{th0}(h))) & !\text{distributed profits net of tax} \\
e &: \text{ptran} & q &: (\text{hg0}(h)*(1-\text{th0}(h))) & !\text{social transfers net of tax} \\
e &: \text{pinv} & q &: (-\text{alphaz}(h)*(\text{sum}(g, \text{cs0}(g)))) & !\text{private savings}
\end{align*}

*Enterprise income and expenditures:

$\text{demand:entr}$

\begin{align*}
d &: \text{pe} & q &: (\text{sum}(h, \text{he0}(h)) + \text{ge0}) \\
e &: \text{pf}("k") & q &: (\text{ef0}("k")*(1-\text{et0})) & !\text{capital income net of tax} \\
e &: \text{pfx}(r) & q &: (-\text{xe0}(r)) & !\text{payments to foreigners} \\
e &: \text{ptran} & q &: (\text{eg0}*(1-\text{et0})) & !\text{social transfers net of tax} \\
e &: \text{pinv} & q &: (-\text{betaz}*(\text{sum}(g, \text{cs0}(g)))) & !\text{enterprise savings}
\end{align*}

*Government income and expenditures:

$\text{demand:govt}$

\begin{align*}
d &: \text{pg} & q &: (\text{sum}(g, \text{gd0}(g))) \\
e &: \text{pinv} & q &: (-\text{gs0}) & !\text{government savings} \\
e &: \text{ptran} & q &: (-\text{eg0}+\text{sum}(h, \text{hg0}(h))) & !\text{social transfers} \\
e &: \text{pe} & q &: \text{ge0} & !\text{distributed profits} \\
e &: \text{pf}("k") & q &: (\text{sum}(h, (\text{hf0}("k", h)*(\text{th0}(h)))))) & !\text{tax on household capital} \\
e &: \text{pf}("l") & q &: (\text{sum}(h, (\text{hf0}("L", h)*(\text{th0}(h)))))) & !\text{tax on household labour} \\
e &: \text{pfx}(r) & q &: (\text{sum}(h, (\text{hr0}(h, r)*(\text{th0}(h)))))) & !\text{tax on household remittances} \\
e &: \text{pe} & q &: (\text{sum}(h, (\text{he0}(h)*(\text{th0}(h)))))) & !\text{tax on household distributed profits}
\end{align*}
Appendix E

\[
e:\text{ptran} \quad q: (\text{sum}(h, h_{0}(h) \cdot (\text{th}_{0}(h)))) \quad !\text{tax on household social transfers}
\]

\[
e:\text{pf}("k") \quad q: (e_{0}("k")) \cdot (e_{0}(t)) \quad !\text{tax on enterprise capital}
\]

\[
e:\text{ptran} \quad q: (g_{0} \cdot (e_{0}(t))) \quad !\text{tax on enterprise social transfers}
\]

*Foreigners’ income and expenditures:

\[
\$\text{demand: foreign}(r)
\]

\[
d:\text{pfx}(r) \quad q: (\text{sum}(g, e_{0}(g, r)))
\]

\[
e:\text{pinv} \quad q: (-f_{0}(r)) \quad r:\text{fsav}(r) \quad !\text{foreign savings}
\]

\[
e:\text{pfx}(r) \quad q: (x_{0}(r)) \quad !\text{enterprise payments to foreigners}
\]

\[
e:\text{pfx}(r) \quad q: (-\text{sum}(h, h_{r}(0, h, r))) \quad !\text{household remittances}
\]

\[
e:\text{pfx}(r) \quad q: (\text{sum}(g, r_{0}(r, g))) \quad !\text{imports}
\]

*Complementarity condition for the scaling parameter \(k_{m}\):

\[
\$\text{constraint: km}
\]

\[
\sum(h, ra(h)) = e= \sum(h, ((1-s_{r}(h)) \cdot (1-th_{0}(h))) \cdot (h_{f}(1, h) \cdot p_{f}(1) + h_{f}(k, h) \cdot p_{f}(k) + h_{e}(h) \cdot p_{e} + h_{g}(h) \cdot p_{g} + (\text{sum}(r, h_{r}(0, h, r) \cdot p_{f}(r))))));
\]

*Complementarity condition for the scaling parameter \(f_{sav}\):

\[
\$\text{constraint: fsav}(r)
\]

\[
f_{sav}(r) \cdot f_{sv0}(r) \cdot \text{pinv} = e= p_{f}(r) \cdot (\text{sum}(g, r_{0}(r, g)))-\text{sum}(g, er_{0}(g, r)) + (x_{0}(r))-\text{sum}(h, h_{r}(0, h, r))) ;
\]

*Complementarity condition for the scaling parameter \(g_{sav}\):

\[
\$\text{constraint: gsav}
\]

\[
\text{govt/pg} = e= (\text{sum}(g, g_{d}(g)));
\]

$report:

\[
v:\text{formprod}(s, g) \quad o:py(g) \quad \text{prod:y}(s)
\]

\[
v:\text{inforprod}(is) \quad o:piy(is) \quad \text{prod:iy}(is)
\]

\[
v:\text{import}(r, g) \quad i:pfx(r) \quad \text{prod:a}(g)
\]

\[
v:\text{export}(r, g) \quad o:pfx(r) \quad \text{prod:x}(g)
\]

\[
v:\text{exportfp}(r) \quad o:pfx(r) \quad \text{prod:es}(r)
\]

\[
v:\text{domuses}(g) \quad o:pd(g) \quad \text{prod:x}(g)
\]

\[
v:\text{margins} \quad o:pt \quad \text{prod:mg}
\]

\[
v:\text{intermed}(g, s) \quad i:pa(g) \quad \text{prod:y}(s)
\]

\[
v:\text{factdeminf}(f, is) \quad i:pf(f) \quad \text{prod:iy}(is)
\]

\[
v:\text{factdem}(f, s) \quad i:pf(f) \quad \text{prod:y}(s)
\]
Appendix E

v:armington(g)  o:pa(g)       prod:a(g)
v:rinvest       o:pinv        prod:invest
v:rcons(h)      o:pc(h)       prod:c(h)
v:rgovt         o:pg          prod:gd
v:renter        d:pe          demand:entr

$offtext
$sysinclude mpsgeset  moz

*Initialization of the scaling parameters and choice of the appropriate closure rule.

km.L=1;

*If the closure rule is EXOGENOUS foreign savings put an asterix before these commands:
fsav.L(r)=1;
fsav.LO(r)=-inf;
**If the closure rule is ENDOGENOUS foreign savings put an asterix before the command:
fsav.FX(r)=1;
*If the closure rule is EXOGENOUS governmemnt savings put an asterix before these commands:
gsav.L=1;
gsav.LO=-inf;
*If the closure rule is ENDOGENOUS government savings put an asterix before the command:
gsav.FX=1;

$include moz.gen
solve moz using mcp;

*Counterfactual: trade liberalization in the SADC area:

tm0(g,"rsa") = 0;
tm0(g,"rosadc") =0;

$include moz.gen
solve moz using mcp;
Appendix F: The 2003 Structuralist/Post-Keynesian SAM

<table>
<thead>
<tr>
<th></th>
<th>Y</th>
<th>IY</th>
<th>Supply</th>
<th>Marg</th>
<th>Enter</th>
<th>Rhhds</th>
<th>Uhhds</th>
<th>Govt</th>
<th>Row</th>
<th>Invest</th>
</tr>
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<tbody>
<tr>
<td>Y</td>
<td>148,354</td>
<td>-148,354</td>
<td></td>
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Source: Author's own calculations

Note: features are Billion MTs

The SAM above is expressed in its MCM format (see chapter 1 for an explanation of MCMs)
Appendix G: The Structuralist/ Post-Keynesian CGE Model Specifications

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Appendix H: The GAMS/ MPSGE Code for the Structuralist/ Post-Keynesian Model

$TITLE A Structuralist/ Post-Keynesian CGE Model for Mozambique

$ontext
This model was developed to assess the impact of the Mozambican participation into the Southern Africa Development Community (SADC). This code is part of the Ph.D. thesis "The Mozambican Participation in SADC- A Liberalization Process trough Different Models and Different Closures". The study was conducted by Elisa Delpiazzo, under the supervision of Prof. Marco Missaglia, University of Pavia. The analysis uses a GAMS/MPSGE CGE model based on the 2003 Mozambique SAM. The focus of the study is on examining the impact of a tariff reduction as the one scheduled in the SADC Trade Protocol.

$offtext

*Define the sets of the model, to use them in the vectorial language of the model:

sets s /Y formal production sector, IY informal production sector/, h /RHHD rural households, UHHD urban households/ alias(s,g);

*Data are inserted in a SAM (in MCM format:)
table sam(*,*)

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*Declare parameters:

parameters
rho | Price elasticity in final import function /-0.418/
sigma| Income elasticity in final import function /1.553/
Pstar| foreign price of imports /1/
Pbar| foreign price of exports /1/
wz(s)| Sector s wage rate in the benchmark
mx(s)| Marketed production of sector s
nmx(s)| Non- marketed production of sector s
gdpz(s)| Total production of sector s
wbill(s)| Wage bill in sector s
b(s)| Input- Output coefficient for labour of sector s
shvaz(s)| Share of value added on GDP in sector s
mz(s)| Mark- up income in sector s
tau(s)| mark- up rate in sector s
mint(s)| Imported intermediates (gross of taxes and margins) used in sector s
dint(s)| Domestic intermediate (gross of taxes and margins) used in sector s
a0(s)| Domestic intermediate input- output coefficient in sector s
Appendix H

a1(s) Imported intermediate (net of taxes and margins) input-output coefficient in sector s
atax(s) Activity tax (subsidy) in sector s
at0(s) Activity tax rate in sector s
vatreb(s) VAT rebate on intermediates used in sector s
rebt0(s) VAT rebate rate on intermediates used in sector s
nmint(s) Net imported intermediates used in sector s
vatb Total VAT collected at borders
vtb0 Tax rate of VAT collected at borders
mtax Total import duties
tm0 Tax rate on imports
fimp Final imports (gross of taxes and margins)
nfimp Net final imports (cif prices)
mrgm Total margins on imports
imrgm(s) Total margins on intermediate imports (cif) used in sector s
mgm0 Margins per unit of imports
dm(s) Total domestic uses
exdp Exports gross of margins
vatd Total VAT on domestic commodity
vtd0 VAT rate on domestic commodities
stax Total sales tax
st0 Sales tax rate
mrgd Total margins on domestic produced goods
t Total supply of domestic final goods
exp exports net of margins
mrgp Total margins on exports
wageinc(h) Wage income for household h
hr0(h) Remittances from abroad of household h
mc0(h) Consumption of imports of household h (gross)
nmc0(h) Net consumption of imports of household h
c0(h) Total consumption of household h
dtax(h) Total direct tax of household h
th0(h) Direct tax rate of household h
hrsv0(h) Total savings of household h
sh0(h) Saving rate of household h
hq0(h) Total social transfers to household h
he0(h) Total distributed profits to household h
dch0(h) Total consumption of domestic good of household h
chome(s,h) Home consumption of goods of sector s of household h
mkincome Total mark-up income
xe0 Total payments to foreigners
dtaxe Total direct tax for enterprises
te0 Direct tax rate for enterprises
esv0 Total savings enterprise
se0 Saving rate for enterprise
eq0 Total social transfers to enterprises
gsv0 Government savings
ge0 Total distributed profits to government
dgd0 Total government expenditures in domestic goods
gd0 Aggregate total government expenditures
mcs Total investments in imported goods (gross of taxes and margins)
nmcs Net total investments in imported goods
inv Total aggregate investments
dcs Total investments in domestic goods
fsv0 Foreign savings
py0(s) Reference price for final production of sector s
rpl(s) Reference price for labour
rpi(s) Reference price intermediate domestic
rpii(s) Reference price intermediate imported
beta1 Share of imports in total capital formation
beta2 Share of domestic goods in total capital formation

*Extraction of data from the SAM.

wz(s)=1;
xz(s)=-sam(s,"supply");
nmx(s)=-sam(s,"rhhds");
whill(s)=-sam("w",s);
Appendix H

\[
\begin{align*}
\text{mrk}(s) &= -\text{sam}("r",s); \\
\text{nmint}(s) &= -\text{sam}("row",s); \\
\text{dint}(s) &= -\text{sam}("supply",s); \\
\text{atax}(s) &= \text{sam}("atax",s); \\
\text{vatreb}(s) &= \text{sam}("vatreb",s); \\
\text{vatb} &= \text{sam}("vatb","govt"); \\
\text{mtax} &= \text{sam}("mtax","govt"); \\
\text{imrgm}(s) &= -\text{sam}("tmm",s); \\
\text{mrgm} &= \text{sam}("tmm","marg"); \\
\text{dm}(s) &= -\text{sam}(s,"supply"); \\
\text{exdp} &= -\text{sam}("supply","row"); \\
\text{vatd} &= \text{sam}("vatd","govt"); \\
\text{stax} &= \text{sam}("stax","govt"); \\
\text{mrgd} &= \text{sam}("tmd","marg"); \\
\text{ts} &= \text{sam}("supply","supply"); \\
\text{mrge} &= \text{sam}("tme","marg"); \\
\text{wageinc}(h) &= \text{sam}("w",h); \\
\text{hr0}(h) &= \text{sam}("rem",h); \\
\text{nmc0}(h) &= -\text{sam}("row",h); \\
\text{dtax}(h) &= -\text{sam}("dirtax",h); \\
\text{hsvo}(h) &= -\text{sam}("sav",h); \\
\text{he0}(h) &= \text{sam}("prof",h); \\
\text{dch0}(h) &= -\text{sam}("supply",h); \\
\text{chome}(s,h) &= -\text{sam}(s,h); \\
\text{mkincome} &= \text{sam}("tmm","enter"); \\
\text{taxe} &= -\text{sam}("dirtax","enter"); \\
\text{esv0} &= \text{sam}("sav","enter"); \\
\text{ge0} &= \text{sam}("prof","govt"); \\
\text{dgd0} &= -\text{sam}("supply","govt"); \\
\text{nmcs} &= -\text{sam}("row","invest"); \\
\text{mcs} &= -\text{sam}("mtax","invest"); \\
\text{mcs} &= -\text{sam}("vatb","invest"); \\
\text{mcs} &= -\text{sam}("tmm","invest"); \\
\text{c0}(h) &= \text{dch0}(h)+\text{mc0}(h)+\text{sum}(s,\text{chome}(s,h)); \\
\text{inv} &= \text{mcs}+\text{dcs}; \\
\end{align*}
\]

*Manipulation of data:

\[
\begin{align*}
\text{gdzp}(s) &= \text{mx}(s)+\text{nmnx}(s); \\
\text{mint}(s) &= \text{nmint}(s)-\text{sam}("mtax",s)-\text{sam}("vatb",s)-\text{sam}("tmm",s); \\
\text{nfimp} &= \text{nmcs}+(\text{sum}(h,\text{nmc0}(h))); \\
\text{fimp} &= \text{nfimp}-(\text{sum}(h,\text{nmint}(s)))-\text{sum}(h,\text{sam}("vatb",h)))-\text{sum}(h,\text{sam}("tmm",h)))-\text{sum}(h,\text{sam}("mtax","invest"))-\text{sam}(s,\text{nmint}(s)); \\
\text{mgm0} &= \text{mrgm}/(\text{nfimp}+(\text{sum}(s,\text{nmint}(s)))); \\
\text{exp} &= \text{exdp}-\text{mrgd}; \\
\text{mc0}(h) &= \text{mc0}(h)+(-\text{sam}("vatb",h))+(-\text{sam}("mtax",s))+(-\text{sam}("tmm",s)); \\
\text{mcs} &= \text{nmcs}+(-\text{sam}("mtax","invest")))-(\text{sam}("vatb","invest"))+(\text{sum}(s,\text{chome}(s,h))); \\
\text{inv} &= \text{mcs}+\text{dcs}; \\
\end{align*}
\]

*Alternative definitions of \( \tau(s) \):

\[
\begin{align*}
\text{tau}(s) &= (((\text{gdzp}(s)+\text{at} \text{tax}(s))/(\text{gdzp}(s)+\text{at} \text{tax}(s)-\text{mrk}(s)))-1; \\
\text{tau}(s) &= \text{mrk}(s)/(\text{wbill}(s)+\text{mint}(s)+\text{dint}(s)-\text{vatreb}(s)); \\
\text{tau}(s) &= (((\text{gdzp}(s)+\text{at} \text{tax}(s)-\text{wbill}(s)-\text{mint}(s)-\text{dint}(s)+\text{vatreb}(s))/(\text{wbill}(s)+\text{mint}(s)+\text{dint}(s)-\text{vatreb}(s)))); \\
\end{align*}
\]

*Manipulation of tax rates:

\[
\begin{align*}
\text{at0}(s) &= \text{at} \text{tax}(s)/\text{mx}(s); \\
\text{rebt0}(s) &= \text{vatreb}(s)/(\text{mint}(s)+\text{dint}(s)); \\
\text{tm0} &= \text{mtax}/(\text{nfimp}+(\text{sum}(s,\text{nmint}(s)))); \\
\text{vtd0} &= \text{vatd}/(\text{sum}(s,\text{dm}(s)))); \\
\text{vtd0} &= \text{vatd}/(\text{sum}(s,\text{dm}(s)))); \\
\text{at0} &= \text{stax}/\text{ts}; \\
\text{th0}(h) &= \text{dtax}(h)/(\text{wageinc}(h)+\text{hr0}(h)+\text{hg0}(h)+\text{he0}(h)); \\
\text{te0} &= \text{dtaxe}/(\text{mkincome}+\text{eg0}); \\
\end{align*}
\]

*Definition of reference prices:
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\[ py0(s) = 1 - at0(s); \]
\[ rpl(s) = 1 + \tau(s); \]
\[ rpi(s) = 1 - rebt0(s); \]
\[ rpii(s) = ((1 + tm0) - rebt0(s)); \]

*Parameters calibrated on the benchmark:

\[ b(s) = \frac{wbill(s)}{(wz(s) \cdot gdpz(s))}; \]
\[ shvaz(s) = \frac{(wbill(s) + mrk(s))}{gdpz(s)}; \]
\[ a0(s) = \frac{dint(s)}{gdpz(s)}; \]
\[ a1(s) = \frac{nmint(s)}{gdpz(s)}; \]
\[ sh0(h) = \frac{hsv0(h)}{(wageinc(h) + hr0(h) + hg0(h) + he0(h) - dtax(h))}; \]
\[ se0 = \frac{esv0}{(mkincome + eg0 - dtaxe)}; \]
\[ \beta1 = \frac{mcs}{inv}; \]
\[ \beta2 = (1 - \beta1); \]

*Show values for parameters:

Display

wz, mx, nmx, wbill, mrk, nmint, dint, atax, vatreb, vatb, mtax, imrgm, mrgm, dm,
exdp, vatsd, mrgd, ts, mrg, wageinc, hr0, nnmc0, dtax, hsv0, hg0, he0, dch0,
chome, mkincome, xe0, dtaxe, esv0, eg0, gsv0, ge0, dqd0, nmcs, dcs, fsv0,
gdpz, mctrl, fimp, fimp, mgm0, exp, mc0, mcs, c0, inv, tau, at0, rebt0, tm0,
vt0d0, vt0b0, st0, th0, te0, py0, rpl, rpi, rpii, b, shvaz, a0, a1, sh0, se0, beta1, beta2;

$ontext

$sectors:

y(s) #domestic productive sectors (formal and informal)
finimp #production of final imports
commx #supply of domestic goods
x #production of exports at final prices
mg #production of wholesale and retail margins
invest #aggregate investment
c(h) #household consumption
gd #government consumption

$commodities:

py(s) #output price for domestic production (formal and informal)
w #wage rate
pxf #exchange rate
pim #import price (in domestic currency)
pt #margin price
pimv #price of investments
pg #price of government consumption
pa #price of distributed profits
pc(h) #price of household consumption
ptran #price of social transfers

$consumers:

ra(h) #households
entre #enterprises
govt #government
foreign #foreigners

$auxiliary:

km #keynesian multiplier
gsav #scaling parameter for government savings
fsva #scaling parameter foreign savings
FINALIMPORT #final imports (to insert the demand function)
INTIMP #intermediate imports (to insert the demand function)

*Sectoral production combines variable costs (labour, imported and domestic intermediates) and a profit mark-up.
*Formal sector earns activity subsidies as Activity tax and VAT rebate.
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$prod: y(s) d: 0 va: 0
o: py(s) q: gdpz(s)
  p: py0(s) a: govt t: (-at0(s))
i: w q: wbill(s)
  p: rpl(s) a: entre t: ((1-te0)*tau(s))
  a: govt t: (te0*tau(s))
i: pa q: dint(s)
  p: rpl(s) a: entre t: ((1-te0)*tau(s)*(1-rebt0(s)))
  a: govt t: ((te0*tau(s)*(1-rebt0(s))) - rebt0(s))
i: pfx q: (nmint(s)*pistar) d: 0
  a: entre t: ((1-te0)*tau(s)*((1+tm0)*(1+vtb0)+mgm0)*(1-rebt0(s)))
  a: govt t: (te0*tau(s)*((1+tm0)*(1+vtb0)+mgm0)*(1-rebt0(s)))+((1-rebt0(s))*(tm0*(1+vtb0)+vtb0)-rebt0(s)*(1+mgm0)))
i: pt q: imrgm(s) d: 0

*Final imports is the aggregation of final uses of imports and transaction margins.
*It involves the collection of a part of import duties and other indirect taxes:

$prod: finimp
o: pim q: fimp
i: pfx q: (nfimp*pistar) a: govt t: (tm0*(1+vtb0)+vtb0)
i: pt q: (mrgm- (sum(s, imrgm(s))))

*Commodity supply of domestic products involves collection of indirect taxes and the application of distribution margins:

$prod: commx
o: pa q: ts a: govt t: st0
i: py(s) q: dm(s) a: govt t: vtd0
i: pt q: mrgd
i: pt q: mrgm

*Export transformation into foreign currency:

$prod: x
o: pfx q: (Pbar*exdp)
i: pa q: exdp

*Production of marketing and transportation margins:

$prod: mg s: 0
o: pt q: (mrgd+mrgm)
i: pa q: (mrgd+mrgm)

*Investment demand:

$prod: invest s: 0
o: pinv q: inv
i: pim q: (beta1*inv)
i: pa q: (beta2*inv)

*Household demand for non-marketed, domestic and imported goods and services:

$prod: c(h)
o: pc(h) q: c0(h)
i: pim q: mc0(h)
i: pa q: dch0(h)
i: py(s) q: chome(s,h)

*Government demand for goods and services:

$prod: gd
o: pg q: gd0
i: pa q: dgd0

*Household income and expenditures:

$demand: ra(h)
d: pc(h) q: c0(h)
e: w q: ((1-th0(h))*wageinc(h)) r: km !net income out of wages
e: ptran q: ((1-th0(h))*hg0(h)) !net income out of social transfers
e: pe q: ((1-th0(h))*he0(h)) !net income out of distributed profits
e: pfx q: ((1-th0(h))*hr0(h)) !net income out of remittances
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\[ e: \text{pinv} \quad q: (-hsv0(h)) \quad \text{!private savings} \]

*Enterprises' income and expenditures:

\[ \$ \text{demand: entre} \]
\[ d: pfx \quad q: (\text{sum}(h, \text{he0}(h)) + ge0) \quad \text{!payments to foreigners} \]
\[ e: \text{pinv} \quad q: (-xe0) \quad \text{!enterprises savings} \]
\[ e: \text{ptran} \quad q: (eg0*(1-te0)) \quad \text{!net income out of social transfers} \]

*Government income and expenditures:

\[ \$ \text{demand: govt} \]
\[ d: pg \quad q: gd0 \quad \text{!social payments} \]
\[ e: \text{ptran} \quad q: (-eg0-\text{sum}(h, hg0(h))) \quad \text{!social payments} \]
\[ e: \text{pe} \quad q: ge0 \quad \text{!distributed profits} \]
\[ e: \text{pinv} \quad q: (-gsv0) \quad r: gsav \quad \text{!government savings} \]
\[ e: w \quad q: (\text{sum}(h, (\text{th0}(h) \times \text{wageinc}(h)))) \quad r: km \quad \text{!direct taxes out of wage income of households} \]
\[ e: \text{ptran} \quad q: (\text{sum}(h, \text{th0}(h) \times hg0(h))) \quad \text{!direct taxes out of social transfers of households} \]
\[ e: \text{pe} \quad q: (\text{sum}(h, (\text{th0}(h) \times he0(h)))) \quad \text{!direct taxes out of distributed profits of households} \]
\[ e: \text{pfx} \quad q: (\text{sum}(h, (\text{th0}(h) \times hr0(h)))) \quad \text{!direct taxes out of remittances of households} \]
\[ e: \text{ptran} \quad q: (te0*eg0) \quad \text{!direct taxes out of social transfers of enterprises} \]

*Foreigners' income and expenditures:

\[ \$ \text{demand: foreign} \]
\[ d: pfx \quad q: (\text{Pbar*exdp}) \quad \text{!enterprise payments to foreigners} \]
\[ e: \text{pfx} \quad q: xe0 \quad \text{!remittances} \]
\[ e: \text{pfx} \quad q: (-\text{sum}(h, hr0(h))) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (l) \quad r: \text{INTIMP} \quad \text{!intermediate imports} \]
\[ e: \text{pfx} \quad q: (l) \quad \text{r: FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]
\[ e: \text{pfx} \quad q: (1) \quad r: \text{FINALIMPORT} \quad \text{!final imports} \]

*Complementarity condition for the scaling parameter km:

\[ \$ \text{constraint: km} \]
\[ \text{sum}(h, ra(h)) = e= \text{sum}(h, ((1-sh0(h))*(1-th0(h)))*(w*km*wageinc(h)+ptran*hg0(h)+pe*he0(h)+pfx*hr0(h))) ; \]

*Complementarity condition for the scaling parameter gsav:

\[ \$ \text{constraint: gsav} \]
\[ \text{govt/pg} = e= \text{gd0}; \]

*Complementarity condition for the scaling parameter fsav:

\[ \$ \text{constraint: fsav} \]
\[ \text{fsav*fsavz*pinv} = e= \text{pfx*((nfimp*Pstar)+(sum(s, nmint(s)*Pstar))-(Pbar*exdp))}+\text{pfx*(xe0-}\text{sum}(h, hr0(h))) ; \]

*Constraint to define the functional form of the intermediate import demand:

\[ \$ \text{constraint: INTIMP} \]
\[ \text{INTIMP} = e= \text{sum}(s, (a1(s)*Pstar*gdpsz(s)*y(s))) ; \]

*Constraint to define the functional form of the intermediate import demand:

\[ \$ \text{constraint: FINALIMPORT} \]
\[ \text{FINALIMPORT} = e= (\text{nfimp}/(\text{sum}(s, gdpsz(s)*y(s)))**\text{sigma})*(\text{pfx*Pstar/pa})**\text{rho}*(\text{sum}(s, gdpsz(s)*y(s)))**\text{sigma} ; \]

*report:
\[ v: \text{rgdp}(s) \quad o: \text{py}(s) \quad \text{prod}: \text{y}(s) \]
\[ v: \text{rlab}(s) \quad i: \text{w} \quad \text{prod}: \text{y}(s) \]
Appendix H

\[
\begin{align*}
\text{v:realint}(s) & \quad \text{i:pfx} \quad \text{prod:y(s)} \\
v:\text{rfinimp} & \quad \text{i:pfx} \quad \text{prod:finimp} \\
v:\text{rexp} & \quad \text{o:pfx} \quad \text{prod:x} \\
v:\text{totmrg} & \quad \text{o:pt} \quad \text{prod:mg} \\
v:\text{rinv} & \quad \text{o:pinv} \quad \text{prod:invest} \\
v:\text{rcons(h)} & \quad \text{o:pc(h)} \quad \text{prod:c(h)} \\
v:\text{rgovt} & \quad \text{o:pg} \quad \text{prod:gd} \\
v:\text{prof} & \quad \text{d:pe} \quad \text{demand:entre} \\
\end{align*}
\]

$\text{offtext}$

$\text{sysinclude} \ mpsgeset \ moz$

*Initialization of the scaling parameters and choice of the appropriate closure rule.*

\[\text{km.L} = 1;\]

*Initialization of the value of INTIMP.*

\[\text{INTIMP.L} = \text{sum}(s, \text{nmint}(s));\]

*Initialization of the value of FINALIMPORT.*

\[\text{FINALIMPORT.L} = \text{nfimp};\]

*If the closure rule is EXOGENOUS foreign savings put an asterix before these commands:*

\[\text{fsav.L} = 1; \quad \text{fsav.LO} = -\text{inf};\]

*If the closure rule is ENDOGENOUS foreign savings put an asterix before the command:*

\[\text{fsav.FX} = 1;\]

*If the closure rule is EXOGENOUS government savings put an asterix before these commands:*

\[\text{gsav.L} = 1; \quad \text{gsav.LO} = -\text{inf};\]

*If the closure rule is ENDOGENOUS government savings put an asterix before the command:*

\[\text{gsav.FX} = 1;\]

*Numeraire of the model:*

\[\text{w.FX} = 1;\]

$\text{include} \ moz.\text{gen}$

\text{solve} moz \text{ using} \text{mcp;}

*Counterfactual: Trade liberalization in the SADC area.*

\[\text{mtx} = 0.027; \quad \text{solve} moz \text{ using} \text{MCP;}
\]